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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FOURTH SEMESTER B.TECH DEGREE EXAMINATION, JULY 2017

Course Code: CH206

Course Name: FLUID AND PARTICLE MECHANICS II (CH)

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any two questions. Each question carries 15 marks.

1 a) Explain any one situation in life where the concept of drag force is applied. (4)

b) Define porosity. How will you calculate actual fluid velocity through a packed bed of given porosity when the superficial velocity is known? (4)

c) We plan to pass air upward through a bed of solids resting on a screen. The solids have a mean particle diameter of 3 mm and particle density of 3200 kg/m^3. The bed has a height of 2.2 m with 0.75 m diameter and a packing factor of 0.4. The inlet and outlet air pressures are 140 kPa and 110 kPa respectively at 100 °C. Will the bed fluidize? (7)

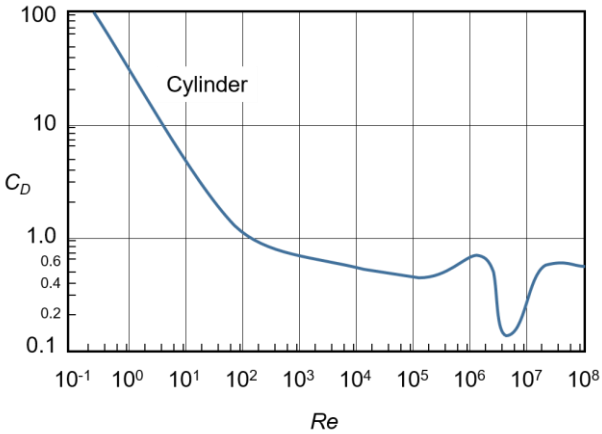
2 a) Drag coefficient varies with Reynold's number; give reasons to this statement. (4)

b) Describe different types of fluidisation with suitable diagrams. (6)

c) How does temperature and pressure affect minimum fluidisation velocity? (5)

3 a) Derive the equation for finding minimum fluidisation velocity of a bed of solids. (8)

b) A vertical cylinder that is 30 m high and 20 cm in diameter is being used to support a mobile antenna. Find the drag force acting on the cylinder and the bending moment at its base. The wind speed is 40 m/s. Given: density of air = 1.2 kg/m^3, viscosity = 1.81×10^5 N.s/m^2. The C_D vs Re plot for a cylinder is as given below. (7)



Assumptions: End effects can be neglected, drag on the antenna may be neglected, the line of action of the drag force is halfway up the cylinder.

PART B

Answer any two questions. Each question carries 15 marks

4 a) Describe the working of 3 types of positive displacement pumps with suitable schematics. (9)

b) A pump delivers 50 l/s flow of water at 30 °C and the intake pipe diameter is 20 cm. The pump intake is located 150 cm above the water surface level in the reservoir. What is the net positive suction head? Given: net frictional losses is given by 0.2 ($V^2/2g$) where V is the average velocity inside pipe; vapour pressure of water at 30 °C is 0.042 atm. (6)

5 a) In large scale industrial operations, compression is often conducted in multi-stages as opposed to single-stage compression. Why is that so? (5)

b) Define Mach number and explain its significance. (5)

c) Determine speed of sound in air at temperature of 20 °C. Given, molecular mass of air ≈ 29, and adiabatic constant = 1.4. (5)

6 a) Explain the working of an instrument for measuring the flow rate of compressible fluids. Derive an equation that can be used for the purpose. (12)

b) When supersonic jet aircrafts cross the sound barrier during their flight, a loud explosion is often heard. What is this phenomenon called and why does that occur? (3)

PART C

Answer any two questions. Each question carries 20 marks.

7 a) Sketch and explain the velocity gradient and velocity patterns produced by a straight-blade turbine inside an agitated vessel. (12)

b) You are appointed as a plant engineer in the crystallisation unit of a pharmaceutical company. Some of the drugs which are crystallised are shear sensitive and hence cannot be exposed to high shear during crystallisation. However, the crystals have to be well mixed to ensure uniform growth as well as to prevent settling. What type of impeller would you choose for the operation? Why? Draw a schematic of the agitated crystallisation vessel along with the flow pattern. (8)

8 a) What are the challenges associated with mixing of high viscosity fluids? How can we overcome each of them? (10)

b) Open straight disc blade turbine set at 40 rpm is used for a pilot plant addition of liquid ingredients into a liquid detergent product. If the pilot and the full-scale plants are geometrically similar in design, what should be the speed of blades be in the full-scale plant based on the following scale-up criteria: (i) constant tip speed and (ii) constant power per unit volume? Diameter of the pilot plant turbine is 0.5 m, and diameter of the full-scale plant turbine is 2.5 m. (10)

9 a) Explain the concept of mixing index. What is the difference of mixing index for solids and pastes? (10)

b) Explain the working and uses of the following: (10)

i) Mixing rolls

ii) Change-can mixer

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